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On the Formation of the Flower Buds of Spring-Blossoming Plants During the Preceding Summer.

By AUG. F. FOERSTE.

For a number of years it has been an interesting subject for me to dissect the scale-protected, and usually subterranean, winter buds of plants blossoming in the spring, in order to ascertain the earliest date at which the *flower*-buds of the *coming* season can be discerned. Having recently had unusually good opportunities for continuing these studies, I present here a part of the results.

The first set of observations were made in the vicinity of Rutland, Vermont, in the district lying between the Green Mountain and the Taconic ranges, during the middle of August. *Sanguinaria Canadensis* then had the flower bud considerably developed, being at least an eighth of an inch long, and containing all the elements of the future blossom in easily recognizable form. *Fragaria Virginiana* showed a cluster of flower buds, the largest of which was a sixteenth of an inch long, the entire cluster being so densely covered with close villous hairs as not to admit of easy recognition of its true character. In *Cornus Canadensis* the flower bud cluster could be readily distinguished, the buds being a thirty-second of an inch or less in diameter. *Pyrola elliptica* has a scaly bud which is not subterranean. The scales being removed, the tiny raceme of flower buds comes to view. Many of the buds have a diameter of less than a fortieth of an inch. *Asarum Canadense* has scaly buds which usually lie flattened close to the ground, covered by fallen leaves, but not subterranean. The enclosed flower bud is about an eighth of an inch long, showing all the structural elements distinctly, although in a miniature form. *Liparis Lœselii* has solid bulbs, toward one side of which, subtended by the inner of the two root leaves, is a small scaly bud, containing the flowering scape of the coming season, the buds of which are so minute as only to be discernable with the aid of a lens. *Smilacina racemosa* shows the terminal panicle, only the lower buds of which can be distinguished even with the aid of a lens. *Maianthemum Canadense*, however, presents these buds in much more recognizable form, being at least a thirty-second of an inch in diameter. *Clintonia borealis* has a scaly bud at the end of a root stalk, usually at least six inches long. In this bud are found the flower buds of the next season distinctly formed in all their parts. Some of the buds slightly exceeded a sixteenth of an inch in length. Nevertheless, the parts were sufficiently well formed to permit me, who not living near its haunts, was up to that time ignorant of the systematic position of the plant, to analyze these flowers which were to blossom next spring sufficiently well to correctly determine its Liliaceous character, and thus to permit its identification. *Trillium erythrocarpum* possessed flower buds a quarter of an inch long and all its parts distinctly developed. *Arisæma triphyllum* presented the so-called "flower" in well developed form, an eighth of an inch long. The spathe was as long as the spadix, and on the latter the minute female elements could be readily detected.

The second set of observations were made during the middle of September, in the vicinity of Mt. Greylock, Berkshire County, Massachusetts. At the northern end of the Bellows Pipe Valley, *Caulophyllum thalictroides* was found, containing in a scaly bud the leaves for the next season's growth, and a dense cluster of tiny buds, about a fortieth of an inch in diameter, and which were destined, when lengthened out, to form the loose panicle of next spring. *Mitella diphylla* reverses the rule in regard to the inflorescence of most spring-flowering plants, by being not directly terminal. The flower clusters are found in lateral elements of the scaly bud on opposite sides of a terminal leaf bud which forms the most important part of the scaly bud. In these lateral buds occur the two leaves which are usually formed half way up the scape of the plant, and the cluster of minute flower buds, rather covered with hairs, which were destined to terminate these scapes of lateral origin.

Along Le Chien's Creek, northeast of Berkshire, Mass., *Uvularia perfoliata* was found with the terminal flower bud at least a quarter of an inch long, and all its elements distinctly formed. *Aralia quinquefolia* showed the flower buds readily, especially when a lens of low power was used. The individual buds were a fortieth of an inch or less in diameter.

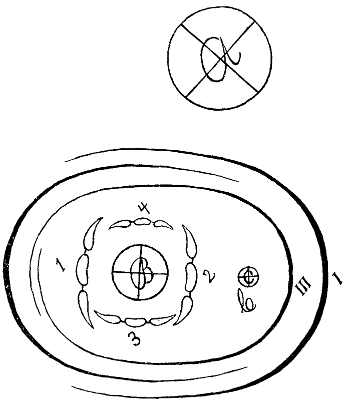

Diagram of *Aralia quinquefolia.*

The third set of observations were made in the latter part of September, between East Nassau, Rensselaer County, and Chatham, Columbia Co., both in New York State. *Thalictrum dioicum* contained the panicle of minute flower buds in recognizable form. *Epigœa repens* had scaly buds hidden among the moss but not covered by soil. On removing the scales, the small flower buds of the next season were readily discovered. *Chimaphila umbellata* also possesses a scaly bud which is not subterranean, but is found at the centre of the cluster of leaves terminating the little erect stalks rising directly from the ground. On removing these scales the minute flower buds can be readily discovered with a lens. *Cypripedium acaule* is another plant with which I had previously been unacquainted. On dissecting the subterranean scaly bud, I discovered two basal leaves and a large bract below the base of a flower bud, at least a quarter of an inch long. The two perfect anthers, on either side of a third sterile one with dilated tip, above the stigma, showed that the specimen was one of the Cypripedieæ, and the inflated, sac-like lip, already distinctly formed suggested that it was a true *Cypripedium* ; whereas the two basal leaves, and the scape-like character of the rest of flowering stem, identified the species as *C. acaule.* In this way, I think it would be readily possible for any one already familiar with the general structure of flowering plants to identify many of the earlier perennial spring-flowering forms out of their season, by means of the flower buds destined to blossom first the ensuing year. *Streptopus roseus* has subterranean scaly buds which when dissected show the leaves of next year, and the extra-axillary flower bud of that season, but at the time examined only a twenty-fifth of an inch long.

In some of my previously published notes I have mentioned similar facts in regard to part of the species cited above, and also other additional varieties. In the January number of the Botanical Gazette of 1883, "The Hibernaculum of *Asarum Canadense*" was described. A paper on "The Hibernacula of Herbs" was published in the November number of the American Naturalist, of 1883. In this paper *Asarum Canadense*, *Arisæma triphyllum*, and *Sanguinaria Canadensis*, were described. In addition to these, the early appearance of flower buds in other spring plants, so far not mentioned in the present article, were noted. *Anemone Hepatica*, *Jeffersonia diphylla*, *Diclytra Cucullaria*, *Claytonia Virginica*, *Uvularia grandiflora*, *Trillium sessile* and *Symplocarpus fœtidus*. Most of these observations were unfortunately made as late as the middle of winter, extending into March, and therefore do not have the value of those taken this year in August and September, but judging from the strongly developed character of the flower buds of these plants when examined, I should judge that their initial stage could be detected much earlier. In the March number of the BULLETIN for 1884, in "The Development of *Dodacatheon Meadia*," the early development of the flower buds of that plant is described. An article entitled "Some Morphological Notes on *Caulophyllum thalictroides*," in the July number of the BULLETIN for 1887, gives some general views on the questions here involved, and is, I hope, substantiated by the additional facts now cited. "The Development of *Symplocarpus fœtidus*," in the June number of the BULLETIN for 1888, gives a fuller description of the curious method of development and arrangement of the flower buds of that plant.

The total number of species investigated by me therefore is twenty-eight. All of these possess the same peculiarity of starting the formation of their flower buds during the summer of the previous year, and often attaining considerable development before the retarding influences of winter become effective. No doubt the warmer sunny days of winter permit still further growth, so that when spring has actually come, the increased warmth causes these flower buds to complete their development rapidly, and to assume the tinted garb in which we are more accustomed to recognize them. The earlier blossoming plants, such as the Blood Root, Twin Leaf, Skunk Cabbage and *Trillium*, usually show their flower buds, in the fall, in a more advanced stage of development than those which flower later. The earlier flowering plants, also, as a rule have shorter stems and possess less foliage than those which blossom later. Perennial plants which do not develop flowers until in late spring or during the summer, of course, also possess scaly winter buds; but these buds only contain the earlier developing leaves; the later leaves and the flowers, are not formed until the scaly bud has burst and the growth of the year has well begun.

The conclusion therefore seems to be, that many spring flowers owe their early development to a combination of circumstances, already determined during the previous summer. These are a decrease in the number of internodes, and hence also, of the leaves produced before the development of flower buds begins; and the early origination and rapid development of flower buds in their scaly covering before winter sets in.

It is probable, that as a rule, the ancestors of spring plants are to be sought in more southerly districts, where the length of the summer and the shortness of the winter season make elaborate winter scale protections for the buds less important. On the other hand, it has seemed to me that the change from a more southerly climate to a northern climate was not exactly calculated to produce spring-flowering plants. It would seem more reasonable to suppose, that as southern plants migrated northwards, the cooler climate would retard their period of flowering so as, at first, to make northern summer flowering plants of the earlier southern types. In the course of time they might adapt themselves to the cooler condition there found.

However, as a plant which had become accustomed to a more northern climate migrated southward, the reverse conditions would operate; and a plant which did not flower until early in the summer farther north, would immediately become a spring-flowering plant on being transplanted to a warmer climate. It is not likely that in the migrations of plants the tendency towards northward migration is very distinct, from the inclination to remain in their more congenial southern homes. However, it is probable that in a general way northern plants, and spring-blossoming plants, are related; and that the causes which tend to produce the one, when exerted in a different way, also tend to produce the other. The result finds its expression in the Botanies, when the distribution of a spring-flowering plant is given as being from a certain line northward, instead of southward, as is apt to be the case of true summer-flowering plants.

It is very natural that the flower buds intended to blossom the succeeding spring should occasionally be prematurely developed by the warm weather towards autumn. Autumn flowering of fall plants has been mentioned so frequently by writers that I will give only two cases in point: *Cornus Canadensis*, found in flower at Rutland, Vermont, late in August; and *Fragaria Virginiana*, also seen in blossom, on Mt. Greylock, near North Adams, Massachuetts.

This, however, is a different phenomenon from the fall-flowering of spring flowers which keep up a desultory sort of flowering all summer, but are apt to blossom again freely in the fall; as is the case with dandelions, chickweed, and similar plants. In the case of the fall-flowering of violets, the fall blossoms are simply the more mature and typical continuation of a long series of flowers, which during the summer are represented only by stunted cleistogamous forms. Then again, many spring-flowering annuals are apt, in the fall, to be again brought to the point of flowering by very favorable weather, from seed which in the ordinary course of nature would have developed to the point of a flowering plant first, the succeeding spring. The cases of the Cornel and Strawberry referred to above, are however, instances of premature development of a flower bud which was already in existence in accordance with the ordinary laws of nature.

Having shown that the development of the flower buds of spring plants, during the previous summer and autumn, was quite a common occurrence, it becomes important now to investigate the life history of certain early spring-blossoming perennials, such as *Dentaria laciniata*, *Erigenia bulbosa*, and *Isopyrum biternatum*, which, although flowering early in the season, do not seem to have the flower buds even started in the winter buds so far examined.